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Resourcing learners' misconceptions on hyperbolic functions through mediation of ICTs at a rural secondary school

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RESEARCH TITLE:

Resourcing Learners' Misconceptions on Hyperbolic Functions through Mediation of ICTs at a Rural Secondary School

Abstract

This study was motivated by the persistent challenge of poor learner performance in mathematics in South Africa, particularly in marginalized communities. A closer analysis of examination and diagnostic reports from both local exit examinations and international comparative tests pointed to some concerning issues in the state of school mathematics in South Africa. Firstly, there is a widening gap in performance in mathematics between more affluent schools and schools in marginalized communities. Secondly, recurring learner errors and misconceptions under functions expose pedagogical shortcomings in this topic. Thirdly, in this technological era, the integration of ICT tools in the teaching of mathematics is lagging far behind and mostly non-existent in marginalized schools. Based on this background, this study sought to explore how ICT-mediated instruction could enhance learner conceptual understanding of functions and minimize their misconceptions in this topic in a rural context.

The study was guided by three research questions. First, it sought to ascertain the learners' errors and misconceptions under hyperbolic functions. Second, it aimed to establish the impact of ICT-mediated instruction in deepening conceptual understanding of concepts under functions, thereby minimizing leaners' misconceptions and third, the study proposed an ICT-mediated instructional model that can provide a context-based framework to teachers on the effective use of ICT tools in the teaching of functions.

The constructivist theories of Social constructivism, Activity theory and APOS theory were merged to provide the theoretical lens for this study. The theoretical argument informing the study was that ICT tools, if properly used, enriches the social (pedagogical) context of the learner and facilitates the reduction of the cognitive gap in the zone of proximal development (ZPD). The nature of issues under investigation in this study naturally called for a qualitative research methodology. Understanding errors and misconceptions involve in-depth study of learners' internal thinking patterns and reasoning. Similarly, ICT-mediated instruction is highly contextual and situational. Thus, the qualitative case study methodology was most appropriate as it allowed for in-depth understanding of the scenario under study.

The study found that learners possess a wide range of misconceptions that make them susceptible to errors in dealing with hyperbolic functions. Algebraic misconceptions came out as the major constraining factor impeding learners' ability to execute procedural calculations. This was exasperated by the finding that learners' conception of hyperbolic functions was restricted to the symbolic (or algebraic) form. Their lack of exposure to multiple representations was reflected in their graphical misconceptions and several representational errors displayed. Calculations were mechanistic and procedural with no understanding of concepts involved. Misconceptions emanating from the asymptotic nature of hyperbolic functions were evident when learners struggled to connect different representations of the same function and to deal with graphical transformations. Failure to understand the language and notational symbols used under functions was another source of errors.

The main findings from this study confirmed that proper ICT integration has potential to deepen conceptualization of functions. The deepening of understanding was explained in terms of Dubinsky's *action – process – object –* and *schema* (APOS) conception levels. Before the ICT-mediated intervention lessons, learners were mainly operating at *pre-function* or *action*-conception level of hyperbolic functions. This conception level is characterized by procedures *without* understanding and memorization of rules. After the lessons, there was glaring evidence that learners had progressed to higher levels of conception. Mental processes of interiorization, encapsulation and thematization were evident in learners' responses after the intervention.

Although the study was context based with limited generalizability, it proposed an ICT-mediated instructional model which highlights affordances and constraints provided by ICTs in the teaching of functions. The model acknowledges that ICT-mediated instruction is situational and underscores the need for the teacher to take cognizance of contextual factors. Its transferability to other contexts should be done with the full knowledge of the context in which this study was undertaken.